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This report contains an account of the Mesoscale Panel's activities over the Contract Period and a list of its recommendations to ASL. (Army Atmospheric Science Lab.)

The Panel's work →

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FINAL TECHNICAL REPORT

Contract No. DAJA45-87-C-0014

The work of the Panel during the contract period has been concentrated into the mesometeorology workshop held at the Risø National Laboratory, Roskilde, Denmark, 12th-15th May, 1987, 2 Panel Meetings (Risø, 14th-15th May, 1987 and PSL, NMSU, 10th-14th April, 1989) and a mini-panel meeting at ASL, September 14th-16th, 1988. This report includes

Accounts of each of these events, apart from the April, 1989 Panel Meeting, are contained in the earlier contract reports. The report of the last Panel Meeting, together with a separate list of its recommendations, R1-R14, is attached herewith. Recommendations R1-R9 reflect the Panel's concern with the status and direction of the mesoscale modelling activities at ASL and propose radical changes which must be implemented if the Army's needs are to make effective use of modern developments elsewhere-both in the U.S. and Europe-in this rapidly developing area of research. Recommendations R10-R13 relate to the project WIND database and reflect the importance the Panel attaches to making this data as widely and speedily accessible as possible. The excellent work of the field phase now needs to be followed up by exploitation of the data by the wider commitments of atmospheric mesoscale modelling if the Army is to benefit from modelling advances elsewhere and improved predictions of mesoscale phenomena.

Professor R. P. Pearce 5th July, 1989

B

DRAFT
REPORT

OF

U. S. ARMY ATMOSPHERIC SCIENCES LABORATORY

16TH MEETING OF THE MESOMET ADVISORY PANEL

10-14 APRIL 1989

BLUE ROOM, PHYSICAL SCIENCE LABORATORY, NMSU, LAS CRUCES, NM

TABLE OF CONTENTS

1. THE PANEL PROGRAMME

The list of participants in the panel meetings is given in Appendix 1 and the agenda is contained in Appendix 2. On the first day, following COL Carlson's welcoming remarks, Mr. Morris described to the panel the enlargement of its role to cover applied as well as basic research activities at ASL. An overview of relevant ASL activities was then presented by the heads of both the Atmospheric Research and Atmospheric Effects divisions.

The second and third days were devoted to the technical presentations (see appendix 7) and the final two days to preparation of the panel recommendations.

Section 2 of this report contains a discussion of the Panel's general reaction to its enlarged role and Section 3 to 8 contain its comments and recommendations covering the wide field of ASL activities with which it is now concerned.

Sections 9, 10 and 11 refer respectively to its future interactions with ASL, its membership and and its meetings.

2. THE ENLARGED ROLE OF THE PANEL

Since its inception in 1973 the Panel has needed to react to frequent changes in the priorities of ASL in its basic research across the whole field of meteorological physics from meso-scale modeling to electro-optical propagation. It has also been aware of the need for close collaboration between scientists in the basic (6.1) and applied (6.2) research areas, although it has had virtually no interaction with the latter. It therefore much welcomes the new initiative taken at this meeting to enlarge its role to cover both areas and accepts the broader frame of reference within which it now operates. It received with much interest all the technical presentations in particular those from the applied area of which it previously had little knowledge.

It gained the overwhelming impression that developments in both areas have now reached the point at which each can benefit substantially from close collaboration with the other and, in some projects, a fusion of activities of the two sections. The benefits to be gained from this are likely to be not only in cost effectiveness, but also in a more unified and better focused scientific effort of the laboratory as a whole. The opportunities for collaboration opened up by the IMETS project are particularly promising.

While realizing that the eventual aim of the work of ASL is to provide tools--in the broadest sense--for the Army, the Panel points out the necessity of coherence within ASL's research program ranging from longer-term strategic research to short-term applied research.

The Panel is struggling to familiarize itself with ASL research areas with which it has so far not been directly concerned as a panel. Among such new items are IMETS, LES, and various software tools for decision-making (e.g., MERCURY).

Through this process of familiarizations which has just begun, it has become increasingly clear that ASL possesses potential which can only be fully utilized if cooperation and cross-fertilization across established organizational borders are strongly encouraged. Thus, for instance, it is apparent that the Applied Research Area (6.2) possesses competency in meteorological modeling which could strengthen considerably the modeling efforts attempted in the Basic Research Area (6.1).

Without suggesting changes in the organization--this is considered outside the Panel's terms of reference--the Panel suggests:

1. That mechanisms be established which ensure that the full potential of ASL is brought to bear on high-priority objectives in spite of apparent organizational constraints.
2. That ASL considers how temporary cross-branch task forces may be established such that transfer of knowledge and technology from research areas to end-user products is facilitated.

RECOMMENDATION

R1. That a link to NMSU be established by creating an academic position at the University which is partly or fully financed by the US Army. This would not only ensure close connections to one or several university departments but also opens the possibility of offering "visiting professorships" at the University which are attractive to members of the academic community and at the same time would give valuable assistance to the scientific activities at ASL.

3. MESOSCALE MODELING (SIGMET)

a. Background

For some years the Panel has been concerned that SIGMET was not a state-of-the-art mesoscale model. The subject of mesoscale modeling has made major advances in recent years and there are a substantial number of well tested models that have significant advantages over SIGMET. At the Panel meeting in RISO, 12-14 May 1987, attention was drawn to this and it was strongly recommended that because of lack of progress with SIGMET development (no sensitivity tests, the large CPU time and the absence of representations of moisture, cloud physics and precipitation) ASL should replace SIGMET in the Hierarchy by one of the validated models developed elsewhere. The ASL response to this recommendation was that it was impractical because it involved an amount of work that was beyond their means (see Appendix 3). At the mini-panel meeting in September 1988, the unsatisfactory state of SIGMET was again raised and it was recommended that high priority be given to speeding up the SIGMET program (which takes 4 hours for a 24-hour forecast on a CRAY-XMP compared with a few minutes for other state-of-the-art models) so that the programme of validating the model and the Hierarchy would be expedited.

b. Current Status

At this Panel meeting, the results of the work to speed up and to validate the model were presented. It appears that the 'perturbation method' (suggested at the September 1988 mini-panel meeting as being the solution to the long integration time) was not successful and that a considerable amount of work would be necessary before it would work satisfactorily. The validation of the model against data from project WIND indicated some deficiencies in the model performance. No results were shown on efforts that had been made to include moisture and precipitation. The Panel formed the view that the considerable amount of work put into SIGMET development since its last full meeting at RISO in 1987 had been largely fruitless. ASL appeared to be putting good money after bad and there seemed to be no case for continuing with work on the model. The Panel discussed the work that might be involved in replacing SIGMET by another model and concluded that it involved two aspects (i) programming to insert the model into the Hierarchy and (ii) in-house familiarization with the scientific make-up of the new model and with its coding and documentation.

The first of these is essentially restricted to reformatting the output of the new model so that it has the same format as the output from SIGMET--a modest task: this could then be fed into SIGTRA (but see Section 4 of this report). The second item of work is longer term. It would involve assigning a member of staff who had meteorological modeling skills (or perhaps a contractor) to work for a substantial period (several months), alongside scientists at the institute which was supplying the new model.

ASL would also need to establish a longer term relationship (probably involving research contracts) with the donor institute.

c. <u>The Future</u>

The Panel noted that the usefulness to ASL of an up-to-date mesoscale model was not restricted to the Hierarchy alone. Several other areas of work presented to the Panel at the meeting required the use of a good, computationally efficient mesoscale model. Also, there is a need for a 4- dimensional data analysis system to be developed; experience from NWP indicates that a good model is an essential requirement to provide a first guess analysis, a best estimate in data sparse areas and a means of ensuring that the analysis obeys realistic physical constraints.

d. <u>Mesoscale Model Linkages with Large Scale Model</u>

The hierarchy of models provides a link between increasingly smaller scales of motion. Initial conditions will reflect the available data. That data may be as extensive as the numeric product of a multi-level, global model, e.g., the USAF relocatable fine mesh model, or as minimal as a single rawinsonde.

RECOMMENDATIONS

R2. All development work on SIGMET should cease forthwith.

R3. SIGMET should be replaced by a state-of-the-art validated mesoscale model (see Appendix 4 for discussion of specific available models).

R4. ASL should write software to reformat the output from the new model so that it resembles output from SIGMET. The new model should be inserted into the Hierarchy.

R5. ASL should make arrangements for a suitable scientist with meteorological modeling skills to be responsible for the implementation and maintenance of the new model. The chosen individual should work alongside scientists at the donor institute and manage a long term contract to ensure continued input of expertise into ASL's mesoscale modeling effort.

R6. The research program should actively explore the initialization of the hierarchy using data from operational models from USAF Global Weather Center, which is the primary source of forecast information to the Staff Weather Officer and to the US Army.

R7. The possibility should be explored of a USAF Staff Weather Officer being assigned to ASL to assist in the implementation of recommendation R6 and complement ASL's research efforts.

4. THE MODEL HIERARCHY

a. The Hierarchy Modules

The panel reviewed the 'White Paper' of September 1988 by Mr. R. Cionco. The paper reviews each of the components of the modeling hierarchy in one document, with a textural description of the activity of each component. This has been helpful to the panel. We wish to commend again the dedicated efforts of Mr. Cionco to bringing these elements together.

The concept of the hierarchy of models is an appropriate concept for the Army to pursue to understand the meteorological fields on the scales important to Army operations--e.g. diffusion, target area surface wind. The hierarchy forms a framework for execution of modules (models) at increasing resolution. The framework must be designed to permit exchange of modules as the *modelling capabilities* develop. In other words the present modules should be replaceable when other modules have demonstrated superior performance.

At its last meeting the panel recommended that the present modules, VARYME, HRW and CANOPY, be tested and evaluated independently against observations. These tests should be conducted at an early date and done in parallel insofar as possible. If the performance of the module is unsatisfactory, ASL should test similar modules, if available in the scientific community.

For certain uses models on these scales should include humidity, e.g., for fog forecasting.

b. <u>The Hierarchy Interfaces</u>

The panel understands that, in addition to transferring data between models, the interfaces SIGTRA (between SIGMET and VARYME) and VARTRA (between VARYME and HRW) perform some limited evaluation of physical processes related specifically to the SIGMET and VARYME models.

It is important that SIGMET, VARYME and HRW be readily exchangeable with other models performing similar functions if the hierarchy is to exploit developments in model technology. The interfaces should therefore be programmed simply to transfer output from one level of the hierarchy into a format suitable for input at the next level down. They should not perform model-dependent calculations of physical processes; the latter should all be included in the models themselves.

c. <u>Two-way Interactive Models</u>

The increase of computational power associated with supermini computers with a cost of 100K-140K U.S. dollars, has permitted the implementation and execution of prognostic primitive equation models on these systems. Along with this engineering development has been the introduction of grid linking algorithms which permits coarse grid data to accurately communicate with finer scale grid information. To insure mathematical consistency, the grid interacting algorithms have been made two-way so that the coarse and fine grids can communicate as accurately as possible with each other. The capability allows the use of telescoping two-way interactive grids so that regional and synoptic scale atmospheric flow can be efficiently and simultaneously linked to mesoscale and smaller domains.

Therefore, with this new development, the one-way hierarchal approach adopted by ASL can be generalized to two-way interactive grids where the same dynamical model can be applied. If desired, one-way diagnostic models, of course, could still be run using the coaser scale dynamic model. However, the use of the dynamic primitive equation model also at the smaller scale should produce more realistic and physically consistent results.

RECOMMENDATIONS:

R8. The VARYME, HRW and CANOPY modules of the hierarchy should be evaluated independently against observations. This evaluation must take precedence over tests of the whole system, including the linkages.

R9. The interfaces should be modified, if necessary, to perform the sole function of data transfer between levels of the hierarchy. They should be clearly defined and documented to enable ready substitution of the modules which they connect

At the same time, high priority should be given to considering, as an alternative approach, the implementation of a telescoping nested two-way interactive primitive equation model on a ~100 K supermini computer at ASL.

5. PROJECT WIND AND THE DATABASE MANAGEMENT

The Panel took note of the fact that Project WIND Phase I-IV was successfully conducted during the period June 1985 to October 1987.

Project Wind was conducted in order to create a database against which ASL's Hierarchal system of nested meso--through microscale models--could be tested. Another purpose was to create a much needed general-purpose database of superior international standard. Both aims were excellently served by the project and seem now to be within reach pending the establishment of a fully accessible database.

The Panel compliments the project group and its leader, Mr. R. Cionco, with its achievements and with the recognition which was manifested by the invitation from the American Meteorological Society to conduct under AMS auspices a symposium on Project WIND. The Panel further recognizes the work which has been further implemented to prepare a thoroughly quality controlled database.

The Panel believes that the data collected constitutes so important a database that no effort should be spared in order to expedite its exploitation. It is imperative to realize that although the WIND database forms the foundation for the testing of ASL's hierarchy of models, its importance and usefulness are much broader. Therefore it is a database which should have multiple users within and outside of ASL. Recognizing the intentions behind the approach presently taken--which is to thoroughly quality control the database as a whole before releasing parts of it--the Panel is of the opinion that this philosophy must be re-evaluated. Also, ASL should consider the data base management as a project in its own right, separate from the testing of the model hierarchy.

RECOMMENDATIONS:

R10. Strong efforts must be made towards getting the basic database for all phases of project WIND in a format which makes data accessible for users at the earliest possible date. Only existing automatic control procedures need be applied for this purpose.

R11. Quality controls additional to those referred to in RISO should be based on statistical sampling methods thereby speeding up the process.

R12. ASL should actively encourage research groups within ASL and outside to utilize the database; ASL should also accept that active use of the database is an important part of the quality control process.

R13. Research groups inside and outside ASL which use WIND data should be required to file at ASL a quality control report on the data they retrieve from the Project WIND database.

6. <u>IMETS</u>

It was with great interest that the Panel heard about the IMETS programme. For obvious time reasons, its underlying philosophy and the details of this system were condensed and did not allow the Panel to formulate any statement or recommendation at this time. Its potential importance for Army operations is evident and the Panel therefore wishes to be kept informed of progress. It proposes that at one of its future meetings, a

detailed discussion be held on this topic. Since COL Carlson announced that IMETS will be demonstrated in Europe next year, the Panel expressed interest in attending this demonstration, possible in conjunction with its future meeting.

7. TACTICAL DECISION AIDS

As part of its expanded role, the Panel was briefed on current work at ASL on tactical decision aids (TDAs). Because of this unfamiliarity of the work, the Panel felt unable to make any specific recommendations, except that there was a need for Panel members to visit appropriate staff at their work place at WSMR to discuss and see the various TDA applications first hand.

The Panel appreciated the importance that TDAs have for the Army in supplying directly applicable information to commanders without the need for intermediate experts to interpret meteorological and other data. Great reliance is being placed on artificial intelligence, expert and knowledge based systems.

There is a need to avoid misapplying so-called 'fragile' methods, i.e., methods tuned to work in a particular geographical area but which break down when used elsewhere. Methods involving a large 'training' effort are likely to be the less useful. A considerable amount of effort needs to be devoted to presenting the output of TDAs in a form that is readily acceptable to and usable by the recipient.

RECOMMENDATION:

R14. The Panel should have the opportunity of seeing the work on TDAs at ASL at first hand.

8. LARGE EDDY SIMULATIONS (LES)

Since the scope of the Panel has been extended to other research fields covered by ASL, the Panel was very interested to hear about the work done on LES. The Panel has not evaluated this work in detail but the results described seem to be interesting and promising as a contribution to basic research in this area. However, the question arises as to whether this type of research should be given high priority at ASL even as basic research since it is being done at other institutes and commits considerable resources of the laboratory in a period of financial constraint. Justification for the continuation of this (or any other) particular area of basic research may have to depend on demonstrating that it has important potential for applicability to the Army's needs.

9. PANEL-ASL INTERACTION

The Panel performs its function by reporting to ASL management through the Technical Director and his appointed staff.

With the broadening of the scope of the panel, its frame of reference goes beyond the Atmospheric Research Division, and now includes some of the work done in the Atmospheric Effects Division. The panel's interaction is concentrated in the programs of the Atmospheric Physics and Meteorology and Observation Branches of the former and the Intelligence and Chemical and Target and Mobilization Branches of the latter. The branch managers should be directly involved in the laboratory's relationship with the panel. In future, the role of the division directors should be flexible and arranged by the Technical Director to respond to circumstances. (See organizational chart in Appendix 5)

The role of the branch chiefs is to consider the recommendations of the panel concerning the work in their branches, and implement whatever the laboratory decides to do about them. The way in which the branch chiefs participated in the panel meeting this week (April 10-14, 1989, Las Cruces) is an acceptable pattern to be projected into the future. On the alternate years when the panel meets in Europe, the branch chiefs would have the additional responsibility of reporting progress in those programs which will not be represented by the Principal Investigator.

A few years ago the Deputy Director was assisted in his relationship with the panel by Mr. Cionco. The Panel expresses its gratitude and appreciation for his competent handling of those duties. These duties have been handled differently since the work of the panel has been performed under a contract with the University of Reading (Prof. Robert Pearce, Principal Investigator). The letter from Dr. Holt to Professor Pearce of March 2, 1989 (Appendix 6) describes these arrangements.

The Panel considers that for the future it would be appropriate for the Technical Director to be the ex-officio ASL member of the Panel. In this task, he will be aided by the Director of the Atmospheric Research Division.

10. PANEL MEMBERSHIP

The Panel welcomed its recent enlarged membership with the addition of Dr. Walter Bach of ARO and Dr. Roger Pielke of CSU. One scientific area which is not covered by the membership, however, is satellite meteorology and the Panel feels that a member should be appointed with extensive knowledge in this field.

11. FUTURE MEETINGS

Two further meetings are suggested. The first, arises from the need for panel members to familiarize themselves more closely with the research of the individual scientists at ASL, particularly those in the applied field (see Recommendation 14); this first is a meeting at ASL during 3-8 November 1989. The second is a meeting in Traben-Trabach, FRG, 23-27 April 1990, organized locally by Dr. W. Klug. The agenda for the latter should cover all of the areas of research at ASL with which the panel is concerned, reviewing progress in each area, whether or not particular project objectives have been reached.

APPENDIX 1

LIST OF PARTICIPANTS

1. Panel Members:

   Professor Robert Pearce, University of Reading, UK
   Dr. Walter Bach, Army Research Office, Durham, NC
   Dr. Niels Busch, Director, Storebaelt, Copenhagen, Denmark
   Prof. Werner Klug, Technische Hochschule Darmstadt, FRG
   Dr. Jehuda Neumann, U. of Copenhagen, Denmark
   Dr. Peter White, UK Met Office, Bracknell, UK

   (Absent Panel Member: Prof. Roger Pielke, CSU, Ft. Collins, CO)

2. Other Overseas Participants:

   Dr. Pinhas Alpert, Dept of Geophysics and Planetary Sciences, Tel Aviv University, Tel Aviv, Israel

   Dr. Chris Jones, Chemical Defense Establishment, Porton, UK

3. ASL Managers:

   COL Gunnar Carlson, Director
   Mr. Gene Morris, Technical Director
   Dr. Howard Holt, Director, Atmospheric Research Division (ARD)
   Mr. Don Shearer, Chief, Meteorology and Obscuration Branch (ARD)
   Dr. Frank Niles, Director, Atmospheric Effects Division (AED)
   Dr. Bernard Engebos, Chief, Intelligence and Chemical Branch, AED
   Dr. Lou Duncan, Chief, Target Acquisition and Mobility Branch (AED)

4. ASL Presenters:

   Meteorology and Obscuration Branch, ARD

   Mr. Ron Cionco
   Dr. John Freeman
   Mr. Gary McWilliams
   Mr. Ron Meyers
   Dr. Montie Orgill
   Mr. Brian Orndorff
   Dr. Henry Rachele
   Dr. Bob Sutherland

Intelligence and Chemical Branch. AED

Mr. Frank Hansen
Ms. Sue Hansen
Dr. Teiji Henmi
Mr. Marty Lee
Mr. David Sauter
Ms. Pam Tabor
Dr. Donna Tucker

Target Acquisition and Mobility Branch. AED

Dr. Mel Heaps

5. Other ASL Participants:

Ms. Barbara Sauter. DP

6. Other Presenters:

Mr. John Byers, PSL
Dr. Roger Davis. STC
Dr. Marvin Kays. STC
Dr. Mike Williams. LANL

AR/7 Apr 89

US ARMY ATMOSPHERIC SCIENCES LABORATORY

16TH MEETING OF THE MESOMET ADVISORY PANEL
10 - 14 APRIL 1989

BLUE ROOM, PHYSICAL SCIENCE LABORATORY, NMSU, LAS CRUCES, NM

AGENDA

Monday, 10 Apr

1300 - 1500	Opening Plenary Session	Chair:	Mr. J. E. Morris
	Welcome and Introduction		COL Gunner Carlson
	The Role of the Mesomet Advisory Panel		Mr. Morris
	The Basic Research Program in Meteorology at ASL		Mr. D. Shearer
	The Applied Research Program in Meteorology at ASL		Dr. F. Niles
1530 - 1730	Closed Panel Session (Panel business meeting)		Dr. E. H. Holt

Tuesday, 11 Apr

0900 - 1230	Basic Research Session	Chair:	Mr. D. L. Shearer
0900	Moisture Profiling Models		Dr. H. Rachele
0940	Large Area Screening Models		Dr. R. Sutherland
1005	Knowledge-Based Systems for Complex Terrain Airflow Modeling		Dr. M. Orgill
1030 - 1100	BREAK		
1100	Mercury: A System for Optimizing the Use of Battlefield Meteorological Data		Mr. G. McWilliams
1145	Physical Processes in Transport and Diffusion		Mr. R. Meyers

1230 - 1400	LUNCH		
1400 - 1630	Applied Research Session	Chair:	Dr. L. D. Duncan
1400	3-Dimensional Chemical Hazard Model		Mr. D. Sauter
1425	Tactical Decision Aids for Smoke		Mr. F. Hansen
1450 - 1510	BREAK		
1510	Aviation Turbulence Model		Ms. S. Hansen Mr. M. Lee
1535	Target Acquisition Models		Dr. M. Heaps
1600 - 1625	Optimum Sensor Placement/Target Area Meteorology		Ms. P. Tabor
1745 - 1915	Supper at the El Paso Marriott/Airport		
1930 - 2130	Open House/Dessert at the Holts 9141 McFall. El Paso (off Hawkins)		

Wednesday, 12 Apr

0830-0930	Conclusion of Applied Research Session	Chair:	Dr. L. Duncan
0830	Prognostic Wind Model		Dr. T. Henmi
0900	Precipitation Models		Dr. D. Tucker
0930-1230	Modeling & Field Study Session	Chair:	Mr. D. L Shearer
0930	Evolution of the Hierarchy of Models		Mr. R. M. Cionco
0955	Modeling Research		Dr. J. Freeman
1010	Conduct of Phase IV and the WIND Symposium		Mr. R. M. Cionco
1055 - 1115	BREAK		

1115 - 1230	DataBase Session:	Chair:	Mr. D. L. Shearer
1115	QC Screening of the DataBase		Mr. R. Davis
1135	Meteorological QC, Analysis, and Error Flagging in the DataBase		Dr. M. Kayes (R. M. Cionco)
1200	Prelininary Analysis of WIND DataBase		Mr. B. Orndorff
1230 - 1400	LUNCH		
1400 - 1730	Simulations Session:	Chair:	Mr. D. L. Shearer
1400	ASL Laboratory Standard: Evaluating the Hierarchy of Models		Mr. R. M. Cionco
1425	Model Simulations at WSMR		Mr. J. Byers
1445	Perturbation Method		Dr. M. Williams
1515 - 1535	BREAK		
1535	WIND Phase I Simulations		Dr. M. Williams
1630	UK Model Simulations and Comparisons		Dr. P. Alpert
1730	End of Session		

<u>Thursday, 13 Apr.</u>

0830 - 1100	Panel Meeting with ASL Management	Chair:	Prof. R.P. Pearce Panel Members Dr. H. Holt Dr. F. Niles Dr. B.F. Engebos Dr. L.D. Duncan Dr. H. Rachele Dr. P. Alpert
1100 - 1700	Preparation of Panel Report: Closed Meeting	Chair:	Prof. R. P. Pearce
1800 - 2100	Panel Supper and Business Meeting - Cattlemen's Restaurant, Fabens, TX		

Friday, 14 Apr

0800 - 1100	Presentation of Panel Report: Discussion	Chair:	Mr. J. E. Morris
		Presenter:	Prof. R. Pearce
1100	Adjourn		

APPENDIX 3

DEPARTMENT OF THE ARMY

US ARMY LABORATORY COMMAND
US ARMY ATMOSPHERIC SCIENCES LABORATORY
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002-5501

REPLY TO
ATTENTION OF

Atmospheric Research Division   3 Jun 88

Professor R. P. Pearce,
Department of Meteorology,
University of Reading,
Reading RG6 2AU,
UK

Dear Professor Pearce,

I am pleased that all the arrangements for Mr. Cionco's visit the week of June 13-17, 1988 have been made. I appreciate your help in ensuring that the appropriate people are available to meet with him-not least yourself, of course!

The principle purpose of the visit is to review the performance of the UK mesoscale model using WIND data. The opportunity to discuss this work with Dr. Alpert, who is flying in from Tel Aviv, Dr. Peter White, UK Met Office and yourself is excellent.

Mr. Cionco will be prepared to discuss the performance of SIGMET and the hierarchy of models using the same 24 hours of data in both cases. The initialization precedures, definition of boundaries and methodology of conducting the runs will be appropriate subjects of discussion so that the comparisons between the models is as fair as possible. The process of simplifying the UK model and using this simplified version to replace SIGMET should also be discussed.

I would appreciate your recommendations about extending the contract to provide for additional work relating the UK mesoscale model to our objectives in Project WIND.

I spoke this morning with Dr. John Bartlett of CDE. He said Mr. Cionco's visit will be a good opportunity to get things back on track so far as cooperative activities at Porton are concerned. He said he saw no reason why Drs. Chris Jones and David Ride couldn't come to Reading. This has the advantage that it not only conserves Mr. Cionco's time but also makes it possible tor you to participate, at least to some extent, in the discussions. Topics of interest would include applications of HRW, measurement of concentration fluctuations, tracer experiments and diffusion models.

We have made an assessment of where we stand in relation to the Panel (P) and Workshop (W) recommendations. In summary:

P1. "There is an overwhelming need for a viable modelling team..the experimental work under Mr. Cionco will need to continue to complete the data base."

COMMENT. We have been unsuccessful in our efforts to hire an experienced modeler. Mr. Cionco's efforts towards the completion of the data base have resulted in the completion of Phase IV with a very high rate of data accession; the implementation of a method of data quality control; and initial plots of Phase I data by the contractor. We have received a report on improved quality control methods from Prof.

Hauser, who you will remember from CSU-Chico, in response to a short contract we placed with him in Jan-Feb 1988.
So far as the hierarchy is concerned the coupling between VARYME and HRW has been improved by including the depth of the mixed layer, surface roughness and stability as initiation parameters and adjustments have been made resulting in more realistic surface temperatures.

P2. "The strategy recommended..involves other mesoscale modeling groups."
COMMENT. Mr. Cionco will be discussing with you how this strategy can be implemented in regard to the UK mesoscale model and the Met Office. Dr. Pielke will be advising us in regard to other US groups.

P3. "The Panel was pleased to hear that the HRW model was being used for experiments at the CDE, Porton..."
COMMENT. Mr. Cionco has provided digitized terrain and HRW wind field simulations for the Porton site but experiments have yet to be carried out. This also will be a topic during his visit. In the meantime we have had the successful conduct of AMADEUS along with the WIND IV work which involved the HRW model with smoke and tracer releases.

P4. "The concern of the Panel, expressed at its last meeting, at the unconvincing physical basis of the VARYME and HRW models was strongly reflected by the workshop participants."
COMMENT. ASL has developed a nesting modeling system which begins with the equations of motion in a prognostic approach to define the meteorological fields of the largest domain (mesoscale). From that solution VARYME and HRW provide diagnostic dynamic adjustments to the SIGMET fields by incorporating the effects of terrain and thermal instability. Although this is not a traditional approach, it is a computationally efficient solution to respond to the Commander's interest in specific microscale locations. The validity of this approach will be determined by the results of the validation process of Project WIND. This validation process will be carried out according to a verification protocol which we are formalizing.

W1. "Considering that.. mesoscale modeling has made big advances..validation of SIGMET still needs to be done..CPU time for SIGMET seems to be large compared with more recent models of the same type.. it is recommended that ASL should install one of the available models which has been validated and include it in the hierarchy..a candidate is a simplified version of the UKMO mesoscale model.."
COMMENT. This recommendation involves an amount of work which has been beyond our means in the time since the Panel last met. Following Mr. Cionco's visit to you, we hope to have the first model comparisons available.

W2. "All or part of the validated WIND data base should be made available to other groups, e.g. the Meteorological Office and Darmstadt, for use in model experiments."
COMMENT. Portions of the WIND data base are just now becoming validated.

W2. "All or part of the validated WIND data base should be made available to other groups, e.g. the Meteorological Office and Darmstadt, for use in model experiments."
COMMENT. Portions of the WIND data base are just now becoming validated. Mr. Cionco should explore this in regard to the Met Office during his visit.

W3. "Each of the hierarchy models should be evaluated independently."
COMMENT. This is part of our verification protocol.

W4. "Concerning the field experiments of atmospheric diffusion planned for Phase IV, concentration fluctuation measurements should be made."
COMMENT. Dr. Jones, CDE, was ready to participate but CDE was unable to finalize the arrangements. We continue to hold this as an important objective.

W5. "The ASL hierarchy is required to provide appropriate inputs into dispersion models..its development must be directed with this in view."
COMMENT. This was taken into account in AMADEUS. We concur in the recommendation.

W6. "Dispersion models should be developed at various levels of sophistication...under some circumstances it may be necessary to represent explicitly the effects of large eddies."
COMMENT. This is being done. Mr. Cionco for AMADEUS and Mr. Meyers for dispersion model development and Large Eddy Simulation research.

As a result of this assessment we feel that we will be in a much better position to present results of data base quality control and model simulation and comparison together with the verification protocol, at a meeting of the Panel in the Spring, 1989. We therefore plan to postpone the September, 1988 meeting of the Panel by approximately six months. We are committed to conduct a session of the AMS meeting in March, 1989 on the subject of Project WIND and it might be appropriate to hold the next Panel meeting in Las Cruces following that meeting.

As you recall, Drs. Pielke and Bach were with us at the RISO meeting and participated in the final wrapup session. We have invited them to join the Panel and they have accepted.

Sincerely,

EHH

E. H. HOLT
Director, Atmospheric Research Division

CF: Panel members.

Possible replacements for SIGMET

There are several modeling systems which could serve as replacements to SIGMET. The U.S. models of this type are summarized in the attached Tables which are reproduced from a report completed for Pacific Gas and Electric/EPRI as related to air quality models. These Tables are an update of the material presented in Appendix B of Pielke (1984, *Mesoscale Meteorological Modeling*). The status of the non-U.S. models as of 1983 is also included with this Appendix. The 1983 status of these non-U.S. models, and other new models (e.g. in Japan), should be updated as completed for the U.S. models in the PGE/EPRI report.

1988

Table 4.1: Comparison of Model Capabilities

	San Jose Model	MASS Model	NCAR/PSU/SUNY Model*	Drexel Model	CSU RAMS Model	ERT CMC/PBL Model Combination	Los Alamos Model
Equations	i) vorticity framework ii) hydrostatic iii) incompressible	i) primitive equation framework ii) hydrostatic iii) anelastic	i) primitive equation framework ii) hydrostatic iii) anelastic	i) primitive equation framework ii) hydrostatic	i) primitive equation framework ii) hydrostatic or nonhydrostatic iii) anelastic	i) primitive equation ii) hydrostatic iii) anelastic	i) primitive equation framework ii) hydrostatic iii) incompressible
Dimensionality	3-D	3-D	3-D	3-D	3-D	3-D/1D	3-D
Grid	staggered	Arakawa A staggered	staggered	non-staggered	Arakawa C staggered grid	staggered	staggered
Horizontal Grid Spacing	i) minimum 1.6 kilometers	i) minimum 7 km	i) 80 km ii) *as small as 1 km*	i) minimum ~25 km	i) minimum ~100 m	i) 127 km	i) minimum 380 m
Vertical Grid Spacing	stretched grid	stretched grid	stretched grid	stretched grid	stretched grid	stretched grid	stretched grid
Model Domain	i) several hundred kilometers on a side	i) arbitrary ii) one-way interactive grid	i) arbitrary ii) *two-way interactive nested version*	i) arbitrary	i) arbitrary ii) two-way interactive iii) telescoping grid	i) northern hemisphere / eastern North America	i) arbitrary ii) one-way interactive grid
Initialization	i) dynamic initialization	i) objective analysis scheme using synoptic[1] analyses including satellite data; removal of integrated mass divergence ii) multivariate variational adjustment scheme planned for December 1989	i) dynamic initialization from synoptic[1] data	i) objective analyses of synoptic[1] data	i) objective analysis scheme of synoptic[1] data ii) vertical normal model initialization (Spring 1989)	i) normal mode initial analysis of synoptic[1] data/ dynamic initialization with nudging towards CMC fields in PBL	i) objective analysis of synoptic[1] data requirement for wind field to satisfy mass conservation
Solution Technique	finite difference	finite difference	finite difference	finite difference	finite difference	spectral (CMC)/ finite element (PBL)	finite difference
Coordinate System	$x-y-z$	$x-y-\sigma_p$	$x-y-\sigma_p$	$x-y-\sigma_s$	$x-y-\sigma_s$	$x-y-\sigma_p$	$x-y-\sigma_s$

1988

Table 4.1: Continued

	San Jose Model	MASS Model	NCAR/PSU/SUNY Model*	Drexel Model	CSU RAMS Model	ERT CMC/PBL Model Combination	Los Alamos Model
Lateral Boundary Layer	open	sponge from synoptic data	*from synoptic data*	from synoptic data	from synoptic data	from synoptic data/ from CMC analyses	from synoptic data and solution of 1-D primitive equations
Top Boundary Conditions	from synoptic specifications; up to present, model top confined to below mid-troposphere	absorbing layer	$\frac{d\sigma_z}{dt} = 0$ at $\sigma = 0$ *absorbing layer*	$\frac{dz}{dt} = 0$	absorbing layer	specified from CMC analyses; PBL model top at 2 km	zero vertical gradient
Surface Boundary Conditions	i) heat energy and moisture surface budgets	i) heat energy and moisture surface budgets ii) specified from satellite iii) representation of vegetation effects	i) heat energy and *moisture surface budgets* ii) *representation of vegetation effects*	i) heat energy budget	i) heat and moisture surface budgets ii) representation of vegetation effects iii) specified from satellite	i) heat and moisture surface budgets ii) representation of vegetation effects	i) heat energy budget ii) representation of vegetation effects
Parameterization of Subgrid Mixing	1st and 2nd order closure	1st order closure	1st order closure	1st order closure	1st or 2nd order closure	1st order closure; a simplified 2nd order closure in the PBL model	2nd order closure
Cumulus Parameterization	none	1-D cloud models	1-D cloud models	1-D cloud models	1-D cloud models	1-D cloud models	1-D cloud models
Radiation Parameterization	i) solar and long-wave radiation at the surface ii) solar and long-wave radiative flux divergence in the atmosphere	i) solar heating of surface long-wave cooling for longer than 24 hour runs (December 1989)	i) solar and long-wave radiation at the surface *ii) long-wave radiative flux divergence in the atmosphere*	i) solar and long-wave radiation at the surface ii) long wave radiation flux divergence in the atmosphere	i) solar and long-wave radiation at the surface ii) solar and long-wave radiative flux divergence in the atmosphere	i) solar and long-wave radiation at the surface ii) long wave radiation flux divergence in the atmosphere	i) solar and long-wave radiation at the surface ii) long-wave radiative flux divergence in the atmosphere

* *Italicized information corresponds to NCAR/PSU version of the code.*
[1] Only upper air synoptic data is used
* *Italicized information corresponds to NCAR/PSU version of the code.*

1988

Table 4.1: Continued

	San Jose Model	MASS Model	NCAR/PSU/SUNY Model*	Drexel Model	CSU RAMS Model	ERT CMC/PBL Model Combination	Los Alamos Model
Stable Precipitation Algorithm	none	i) rainout for relative humidity greater than 100% ii) ice microphysics representation in cirrus anvil clouds	i) rainout for relative humidity greater than 100%	i) includes equations for cloud liquid water and rain water – 1st order parameterisation	i) includes equations for cloud ice, cloud liquid water, snow, and rain – 1st and 2nd order parameterisations	i) gradual rainout based on a dewpoint depression threshold dependent upon large-scale environment	none
Algorithms to Link to Other Models	i) plume models ii) Eulerian chemical models iii) Eulerian dispersion models iv) cloud models	i) trajectory model ii) 3-D nonhydrostatic cloud scale model	i) Eulerian chemical model (RADM)	none	i) advection diffusion (Eulerian dispersion) model ii) SAI chemistry model iii) Lagrangian dispersion model	i) Eulerian chemistry model (ADOM)	i) Lagrangian particle dispersion model
Phenomena Studied of Relevance to Northern California	i) polluted urban coastal boundary layer	i) extratropical cyclones ii) frontal system iii) mesoscale convective circulations iv) sea breezes v) plume transport and acid rain deposition vi) squall line	i) extratropical cyclones ii) *sea-land breezes* iii) *forced airflow over rough terrain* iv) *frontal circulations* v) *mesoscale convective systems*	i) frontal zones ii) mesoscale convective circulations iii) cyclogenesis iv) heavy precipitation events	i) orographic precipitation ii) topographically induced gravity waves iii) turbulence structure in the boundary layer iv) extratropical squall lines v) transport and dispersion of pollutants vi) sea-land breezes vii) mountain-valley flow	i) acid deposition ii) oxidant formation	i) diurnal variation of planetary boundary layer ii) sea breezes iii) nocturnal drainage flow iv) formation of plumes over a cooling pond v) turbulence in cloud in marine boundary layer vi) long range transport

1988

Table 5.1: Summary of Model Capabilities

	San Jose Model	MASS Model	NCAR/PSU/SUNY Model*	Drexel Model	CSU RAMS Model	ERT CMC/PBL Model Combination	Los Alamos Model
1. Able to explicitly represent clouds and fog (i.e. to prognose or diagnose cloud water or cloud ice)	no	no	no	yes (water clouds)	yes	no	yes, using a statistical procedure for nonprecipitating cumulus water clouds
2. Appropriate tool which could be used to estimate transport over the complex terrain of northern California	not unless terrain-following coordinate system is added	yes	*yes*	yes	yes	no	yes
3. Able to represent boundary layer processes in complex terrain and coastal environments	no (no terrain in model)	yes	*yes*	yes	yes	no	yes
4. Nested grid versions	no	yes	*yes*	no	yes	no	yes
5. Satisfactory numerical solution algorithms as based on prior performance	yes	yes	yes	yes	yes	yes	yes
6. Needed data for initialization	i) synoptic	i) synoptic upper air ii) terrain iii) vegetation/soil	i) synoptic upper air ii) terrain iii) *vegetation/soil*	i) synoptic upper air ii) terrain	i) synoptic upper air ii) terrain iii) vegetation/soil	i) synoptic upper air ii) terrain iii) vegetation/soil	i) synoptic upper air ii) terrain iii) vegetation/soil
7. Needed data for mesoscale validation	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California	mesoscale resolution wind, turbulence, and temperature data; at minimum of 20 equispaced surface and sounding data throughout northern California
8. Summary of ease of application to northern California (i.e. need for major model development)	major development work needed	relatively minor development work needed	major development work needed in SUNY version; relatively *minor* development work needed for NCAR/PSU research version	major development work needed	relatively minor development work needed	very major development work needed	relatively minor amount of development work needed (for nesting algorithm)

* Italicized information corresponds to NCAR/PSU version of the code.

A *Alpert–Neumann Mesometeorological Model*. P. Alpert, A. Cohen, E. Doron, and J. Neumann.

B Hydrostatic, primitive equations (but in the sigma-system).

C 2-*D*.

D 65 × 10.

E 4 km.

F Variable with height: distance between levels increasing with height. Levels, 10 in number, at following altitudes (m): 10, 20, 35, 60, 110, 200, 350, 640, 1150, and 2100. (Rounded-off values.)

G 260 km.

H Initial surface pressure 1000 mb.
Initial horizontal temperature gradient: zero.
Initial lapse rate with height: from surface up to 930 mb, $\partial T_0/\partial z = -6.5°\mathrm{C\,km^{-1}}$; from 930 to 900 mb an inversion with $\partial T_0/\partial z = +1.5°\mathrm{C\,km^{-1}}$; from 900 mb to top pressure $p_T = 750$ mb, $\partial T_0/\partial z = -6.5°\mathrm{C\,km^{-1}}$.

I Horizontal advection, pressure gradient, and turbulent transfer: Marchuk's (1974) splitting method with horizontal advection involving cubic-spline interpolation (Long and Pepper, 1976); in vertical diffusion terms use is made of a semi-implicit scheme similar to that of Paegle *et al.* (1976), adapted to the sigma system; see Alpert (1981).

J $\sigma = (\bar{p} - \bar{p}_T)/(\bar{p}_{z_G} - \bar{p}_T)$; $\bar{p}_T$ is pressure at top of model atmosphere.

K $\partial/\partial x = 0$ at $x = 0, D_x$.

L $\partial/\partial z = 0$ and $\dot{\sigma} = 0$.

M Diurnal variation of ground-surface temperature prescribed; sea-surface temperature constant; $\dot{\sigma} = 0$.

N Form of vertical diffusion terms: $(g^2/p_*^2)\partial/\partial\sigma(\bar{p}^2 K_z \partial/\partial\sigma)$ with $K_z = l^2 S f(\mathrm{Ri})$, S = shear, $l = kz/(1 + kz/\lambda)$, $\lambda = 40$ m.
Form of $f(\mathrm{Ri})$ specified in Alpert *et al.* (1982, Sec. 3, p. 997).
$p_* = \bar{p}_{z_G} - \bar{p}_T$.

O None.

P None.

Q None.

R None.

S Strong afternoon winds in the summer season in the Jordan Valley, area of Lake Kinneret, about 45 km east of Mediterranean coast of Israel. Alpert and Neumann also applied it to the case of a double land breeze over southern Lake Michigan, Alpert and Neumann (1983).

T CDC Cyber.

A *United Kingdom Meteorological Office Mesoscale Model*. B. W. Golding, R. N. B. Smith, R. J. Purser, N. Machin.

B Nonhydrostatic, compressible (Tapp and White, 1976).

C 3-*D* (Tapp and White, 1976).

D Variable, movable. At present 62 × 61 × 10, will be 16 levels. (Carpenter, 1979; Bailey *et al.*, 1981).

E Usually 10 km. 1 km has been used.

F Variable. 10 m at surface to 1500 m at 12 km (Tapp and White, 1976; Carpenter, 1979).

G At present, 610 × 600 × 4 km. Will be 12 km in vertical (Carpenter, 1979).

H Static initialization based on fields from large scale (75-km grid) model. (Carpenter, 1979; Carpenter and Lowther, 1982).

I Second-order centered differences. Implicit treatment of sound waves (Tapp and White, 1976).

J $x, y, \sigma = z - z_G$

K and L Normal velocity and gradient of other parameters except pressure specified. Upstream advection at boundary (Carpenter, 1979).

M $w = 0$; surface energy budget (Carpenter, 1979).

N $1\frac{1}{2}$-order turbulence scheme, prognostic turbulent kinetic energy equation.

O None, will have modified version of Fritsch and Chappell.

P Surface budget. Affects of moisture and cloud will be incorporated (Bailey *et al.*, 1981).

Q Prognostic cloud water. Precipitation includes evaporation and accretion; instantaneous fallout.

R —

S Sea breeze, formation of multicell storm, orographic flows, cumulus dynamics (Carpenter, 1979; Bailey *et al.*, 1981).

T Cyber 205 (2 pipes). One half hour CPU time for 24-h forecast.

A Etablissement d'Etudes et de Recherches Météorologiques, Centre National de la Recherche Météorologique (Toulouse, France). Team: MC2—C. Blondin, S. Biere, B. Bret, P. Lacarrere, O. Thual. Collaborators: G. Therry, J. C. Andre.

B Hydrostatic, incompressible or anelastic, boussinesq approximation (Blondin, 1979).

C 2-*D* and 3-*D*.

D Cyber code (CDC 175), max: $45 \times 45 \times 12$. CRAY-1 code, max: $55 \times 55 \times 15$.

E 5 km $< \Delta x, \Delta y <$ 20 km.

F Variable vertical resolution, but with first level at the top or in the surface boundary layer (50 m), a few levels in the planetary boundary layer, top of the model at 250 or 200 mb.

G Typically a few hundred kilometers in the horizontal, a few kilometers in vertical (Blondin, 1980).

H Objective analysis of radar wind and radio soundings, without use of balance equation.

I Second-order numerical scheme in space and time (leap frog). Implicit resolution for vertical diffusion and external gravity wave propagation.

J $x, y, \sigma = s(z - z_G)/(s - z_G)$.

K Different types depending on the problem. (1) Fixed lateral boundary conditions. (2) Fixed at the inflow points, zero gradient at the outflow points. (3) Prescribed time dependent boundary conditions. In all cases, increasing horizontal diffusion toward the boundaries.

L Rigid.

M For the surface fluxes: Monin–Obukov similarity theory. Blackadar surface temperature evolution equation.

N Two possibilities: (1) $K = K(Ri)$, (J. F. Louis), and (2) $K = cl\bar{e}^{1/2}$ where c is a numerical constant, l a mixing length, and $\bar{e}$ the averaged subgrid scale kinetic energy (Therry and Lacarrere, 1983).

O No.

P ECMWF Radiation scheme (J. F. Geleyn).

Q No.

R Quasi-hydrostatic formulation (Orlanski method). Hydrologic cycle with validated parameterization of latent heat flux plus parameterization of "warm" clouds (without ice phase) and associated precipitation.

S Sea-land breezes, mountain valley winds, föehn effect, katabatic winds (Blondin and Therry, 1981).

T CYBER 175, CRAY 1. Typically, for the 3-*D* model, 3000 s CPU for 3-h real time simulation on CDC (Grid: $45 \times 53 \times 12$), 1000 s CPU for 3-h real time simulation on CRAY-1 (grid: $55 \times 55 \times 15$).

A *Technical University*, Darmstadt, Dept. of Meteorology, Karolinenplatz, D-6100 *Darmstadt*, F.R.G. Model: "FITNAH" (Flow over irregular terrain with natural and anthropogenic heat sources), F. Wippermann, F. Wallbaum, G. Gross, Pflüger*.

B Primitive equations, Boussinesq approximation for deep convection, i.e. $\rho = \rho_0(z)$. Nonhydrostatic (balance equation for the pressure deviation).

C 2-*D* and 3-*D*. Most runs in 2-*D* because of lack of computer time.

D Variable, mostly $40 \times 40 \times 15$; for 2-*D*-runs also 60×18; staggered grid.

E $\Delta x = \Delta y = 300$ m for Inn Valley (Austria) and for drainage flow investigations. $\Delta x = \Delta y = 500$ m for Discmma Valley (Switzerland) and similar situations (for instance Rhein Valley). Most runs with $\Delta x = \Delta y = 1000$ m. Several runs (for instance, sea breeze) with $\Delta x = \Delta y = 2500$ m.

F Variable, depending on the problem. Mostly smallest Δz (at the earth surface) 15 m; largest Δz (at the upper boundary) 1000 m. But, for instance, in drainage flow studies: smallest $\Delta z = 4$ m, largest $\Delta z = 20$ m.

G Largest: 100 km × 100 km × 8000 m. Smallest: 12 km × 12 km × 1500 m (for drainage flow studies).

H at $t = 0$ the 3-D-fields are filled in by the solutions of the 1-D-model version ($z_G = 0$). "Diastrophy" for about 10 min real time, i.e., $z_G \neq 0$. Adaptation after 3–5 h, depending on the forcing from the ground $\theta_0(x, y, z_0, t)$

I Centered differences, upstream for the advection terms; forward in time (either Euler-direct or Euler backward).

J Terrain following: x, y, σ; $\sigma = (z - z_G)/(s - z_G)$.

K *Inflow* boundaries: in the 3-D-version from a 2-D-model and this from a 1-D-model with given $V_{geostrophic}(z), \theta_0(z)$ and $q_{3_0}(z)$; $\partial/\partial n(a) = 0$, $a = \bar{u}, \bar{v}, \bar{w}, \bar{\theta}, p', \bar{q}_3$, where the derivative is perpendicular to the boundary. *Outflow* boundaries: $\partial^2/\partial n^2(a) = 0$, $a = \bar{u}, \bar{v}, \bar{w}, \bar{\theta}, \bar{q}_3$; $\partial/\partial n(a) = 0$, $a = p'$.

L (a) fixed boundary, $s =$ constant, or (b) free surface $s = s(x, y, t)$. An absorbing layer below s can be used.

M $z = z_0$: $\bar{u} = \bar{v} = \bar{w} = 0$, $\bar{\theta}$ from surface energy budget, $\bar{q}_3$ by using a prognostic equation for W_G; the water content of the ground. Interface $z = z_0$ to $z = 0$ needed. $z = 0$: $\partial \bar{p}'/\partial z = g\bar{\rho}\,\theta'/\bar{\theta}$.

N *K from a mixing-length hypothesis (dependent on local Ri, or in case of windless* convection on the Brunt Väisala frequency).

O —

P Scheme of Zdunkowski, Geleyn and Korb for longwave radiation.

Q FITNAH IIIa: instantaneous fallout after saturation. FITNAH IIIb: inclusion of liquid water content in form of cloud drops and of rain drops (Kessler scheme).

R —

S Heat island; sea–land breezes; *mountain–valley winds; forced airflow over rough* terrain.

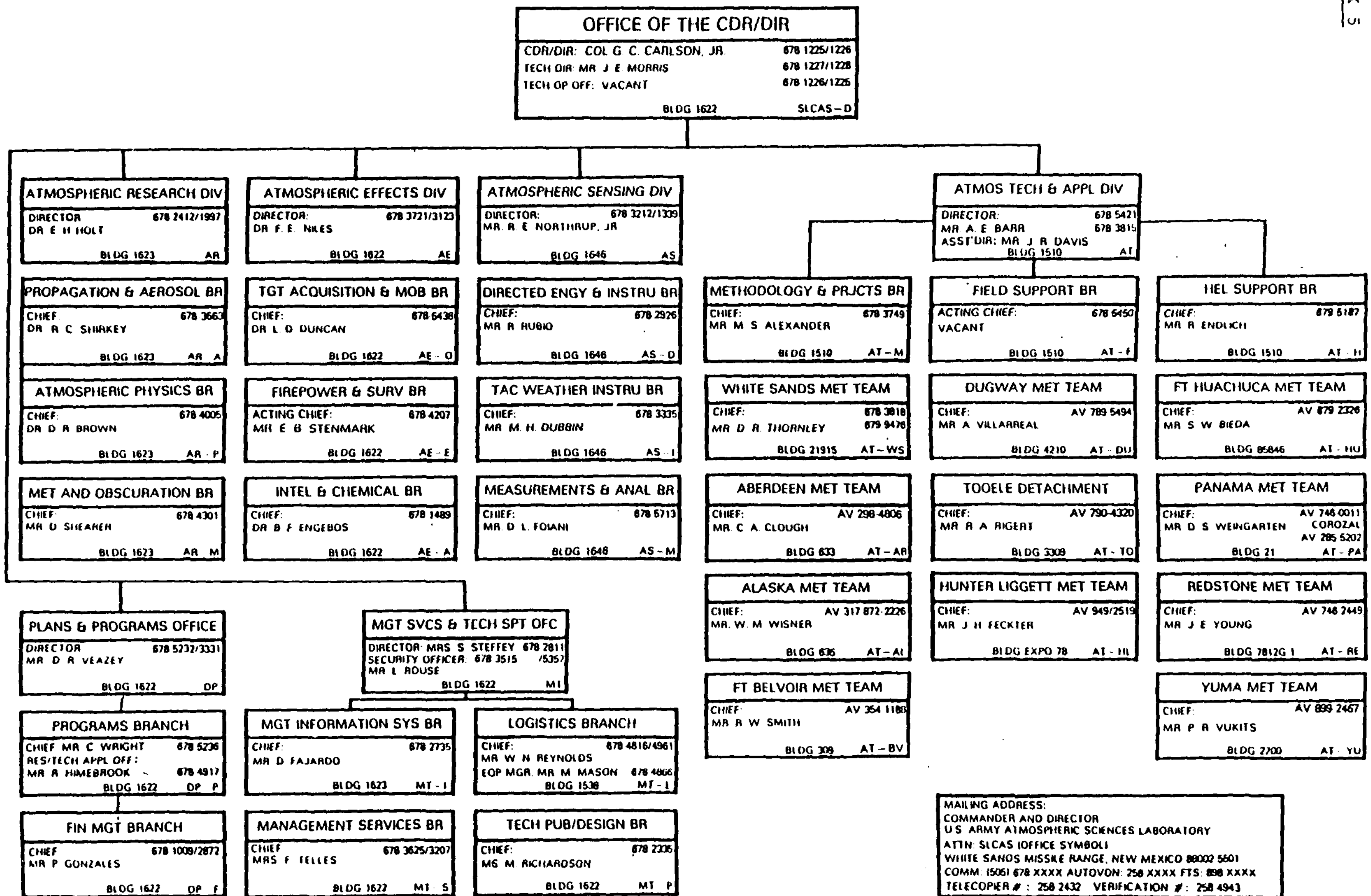
T IBM 370/168. CPU-Time/Realtime ~2

APPENDIX 5

U.S. ARMY ATMOSPHERIC SCIENCES LABORATORY

U.S. ARMY LABORATORY COMMAND

WHITE SANDS MISSILE RANGE, NEW MEXICO



MAILING ADDRESS:
COMMANDER AND DIRECTOR
U S ARMY ATMOSPHERIC SCIENCES LABORATORY
ATTN: SLCAS (OFFICE SYMBOL)
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002 5601
COMM: (505) 678 XXXX AUTOVON: 258 XXXX FTS: 898 XXXX
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DEPARTMENT OF THE ARMY

APPENDIX 6

US ARMY LABORATORY COMMAND
US ARMY ATMOSPHERIC SCIENCES LABORATORY
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002-5501

REPLY TO
ATTENTION OF

March 2, 1989

Atmospheric Research
Division

Dr. Robert P. Pearce
Department of Meteorology
University of Reading
2 Early Gate, Whiteknights
P. O. Box 239
Reading RG6 2AU
UK

Dear Dr. Pearce:

We are looking forward to the meeting of the Mesoscale Advisory Panel, April 10-14, 1989 in Las Cruces. We would like to broaden the scope of this meeting, the first in two years, by asking the panel to critique all of our mesoscale work in the Technical Base Program at ASL. This includes work in the basic research (6.1) program under the supervision of Mr. Donald Shearer (with myself as division director) and work in the applied research (6.2) program under the supervision of Dr. Bernard Engebos (with Dr. Frank Niles as division director).

I enclose reports of this work and material describing the status of our projects in FY89 and plans for FY90.

To benefit fully from the expertise of the panel members, we would appreciate it if there could be some presentations by panel members of recent developments in mesoscale modeling and validation--particularly from the point of view of the ASL program as described in the material enclosed.

To facilitate communications, I am sending the same material to Dr. Bach and request that you coordinate with him by telephone.

With these broad goals in mind, I think it would be best if you respond with a proposed agenda which reflects the way in which you see the Panel best accomplishing its work during the week of meetings.

Since we have had a contract with you at the University of Reading, the work previously falling to the Secretariat, Mr. Ron Cionco, has been discharged by you in consultation with myself. Furthermore, with the change in the scope of the panel described above, the panel's interaction with ASL research program will be considerably broader than Mr. Cionco's work alone. For these reasons, I have though it best to abolish the Secretariat function. I do this with appreciation to Ron for his dedication to the Panel's work. He has not only written agendas and meeting minutes but also took over the Panel chairmanship in 1983 when neither Dr. Rachele nor Mr. Horning were able to attend the scheduled meeting, thus ensuring the continuity of the Panel's work. We owe him a debt of gratitude.

I suggest that, on the first day, we plan an opening session with Mr. Morris to review the role of the panel, gain a broad perspective on the ASL program from Mr. Shearer and Dr. Engebos, and discuss the major objectives of the meeting.

During discussions at ASL of the approach taken by Mr. Cionco in developing the ASL hierarchy of models, Colonel Carlson has suggested that these ideas be set out in a white paper and distributed to the panel. This is also enclosed.

Sincerely,

E H Holt

E. H. Holt
Director, Atmospheric Research Division

Enclosures

Copy Furnished:

Dr. Walter Bach, Director, USA Research Office

RECOMMENDATION

R1. That a link to NMSU be established by creating an academic position at the University which is partly or fully financed by the US Army. This would not only ensure close connections to one or several university departments but also opens the possibility of offering 'visiting professorships' at the University which are attractive to members of the academic community and at the same time would give valuable assistance to the scientific activities at ASL.

RECOMMENDATIONS

R2. All development work on SIGMET should cease forthwith.

R3. SIGMET should be replaced by a state-of-the-art validated mesoscale model (see Appendix 4 for discussion of specific available models).

R4. ASL should write software to reformat the output from the new model so that it resembles output from SIGMET. The new model should be inserted into the Hierarchy.

R5. ASL should make arrangements for a suitable scientist with meteorological modeling skills to be responsible for the implementation and maintenance of the new model. The chosen individual should work alongside scientists at the donor institute and manage a long term contract to ensure continued input of expertise into ASL's mesoscale modeling effort.

R6. The research program should actively explore the initialization of the hierarchy using data from operational models from USAF Global Weather Center, which is the primary source of forecast information to the Staff Weather Officer and to the US Army.

R7. The possibility should be explored of a USAF Staff Weather Officer being assigned to ASL to assist in the implementation of recommendation R6 and complement ASL's research efforts.

RECOMMENDATIONS:

R8. The VARYME, HRW and CANOPY modules of the hierarchy should be evaluated independently against observations. This evaluation must take precedence over tests of the whole system, including the linkages.

R9. The interfaces should be modified, if necessary, to perform the sole function of data transfer between levels of the hierarchy. They should be clearly defined and documented to enable ready substitution of the modules which they connect

At the same time, high priority should be given to considering, as an alternative approach, the implementation of a telescoping nested two-way interactive primitive equation model on a ~100 K supermini computer at ASL.

RECOMMENDATIONS:

R10. Strong efforts must be made towards getting the basic database for all phases of project WIND in a format which makes data accessible for users at the earliest possible date. Only existing automatic control procedures need be applied for this purpose.

R11. Quality controls additional to those referred to in R1SO should be based on statistical sampling methods thereby speeding up the process.

R12. ASL should actively encourage research groups within ASL and outside to utilize the database; ASL should also accept that active use of the database is an important part of the quality control process.

R13. Research groups inside and outside ASL which use WIND data should be required to file at ASL a quality control report on the data they retrieve from the Project WIND database.

RECOMMENDATION:

R14. The Panel should have the opportunity of seeing the work on TDAs at ASL at first hand.